agrees that there is support in the application for an etchant gas that does not contain hydrogen.

Claim 24 is directed to an etchant gas consisting essentially of a *hydrogen-free fluorocarbon gas*, an oxygen-containing gas and a optional carrier gas. Claim 25 is directed to an etchant gas consisting of a *hydrogen-free fluorocarbon gas*, an oxygen-containing gas and a optional carrier gas.

The terminology "consists essentially of" in Claim 24 or "consists of" in Claim 25 relates to "transitional phrases" used to define the scope of a claim. See MPEP §2111.03 "Transitional Phrases." Given the explanation of the definition of such phrases in the MPEP, it is submitted that there is no need for such terms to be discussed in the specification.

Support for the claimed hydrogen-free etch gas can be found in the specification as follows:

> Especially good selectivity of oxide to nitride can be obtained when the etch gas is free of hydrogen and/or nitrogen. (Emphasis added, page 17, lines 19-20.)
>
> The fluorocarbon is preferably hydrogen-free and may comprise at least one C_xF_y gas... (Emphasis added, page 18, lines 20-21.)
>
> According to the invention, oxygen is added in an amount effective to control the etch rate selectivity of the etching gas chemistry. That is, the oxygen is effective to prevent etch stop by reacting with polymer at the bottom of the etched openings. The advantageous effects of the invention can be achieved by supplying the oxygen reactant and fluorocarbon reactant to plasma etching reactor at a flow rate ratio of oxygen reactant to fluorocarbon reactant of 1.5 or less. For selective etching of BPSG in a

> medium density plasma etch reactor, the flow rate ratio of oxygen reactant to fluorocarbon reactant is preferably 0.5 to 1.2...[t]he etching gas mixture may optionally include other gases and/or an inert carrier gas such as argon (Ar), helium (He), neon (Ne), krypton (Kr), xenon (Xe) and mixtures thereof. (Emphasis added, page 18, line 12 through page 19, line 3.)
>
> The process of the invention is useful for obtaining extremely high dielectric:nitride etch selectivity of at least 10:1...For example, etching of a BPSG layer can be carried out for about 1 minute in a single step with... 260 sccm Ar, 12 sccm O_2, 11 sccm C_4F_6. (Page 20, lines 9-21).

From the foregoing excerpts and examples from the specification, Applicants respectfully submit that the subject matter of Claims 24-25 does not introduce any new matter. The specification clearly discloses a hydrogen-free etch gas and a hydrogen-free fluorocarbon gas such as C_4F_6. Thus, this rejection should be withdrawn.

Second Rejection

Claims 1-5, 9-12 and 14-25 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,174,451 to Hung et al. ("Hung") in view of U.S. Patent No. 6,074,959 to Wang et al. ("Wang"). The reasons for this rejection are set forth in numbered paragraph 3, on pages 3-7 of the Official Action. In particular, the Official Action alleges that (1) Wang discloses the use of an oxygen-containing gas with a fluorocarbon main etchant gas to etch an oxide (dielectric) layer; and (2) it is argued that it would have been obvious to modify the C_4F_6-based oxide etch of Hung to include the oxygen-containing gases of Wang. This rejection is respectfully traversed for the following reasons.

Reconsideration of the rejection is requested in view of the following legal precedent regarding rejections based on a combination of prior art references.

> The Supreme Court in Graham v. John Deere, 383 U.S. 1, 18, 148 USPQ 459, 467 (1966), set forth the basic test for patentability under 35 U.S.C. § 103: Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved need, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter to be patented.

In In re Ehrreich and Avery, 200 USPQ 504, 509-510 (CCPA 1979), the Court of Customs and Patent Appeals further clarified the basic test set forth in Graham v. John Deere:

> We must not here consider a reference in a vacuum, but against the background of the other references of record which may disprove theories and speculations in the reference or reveal previously undiscovered or unappreciated problems. The question in a § 103 case is what the references would collectively suggest to one of ordinary skill in the art. In re Simon, 461 F.2d 1387,174 USPQ 114 (CCPA 1972). It is only by proceeding in this manner that we may fairly determine the scope and content of the prior art according to the mandate of Graham v. Deere Company, 383 US 1, 17, 148 USPQ 459, 467 (1966) (emphasis in original).

Regarding the scope and content of the prior art inquiry of Graham v. Deere Company, any reference that is relied upon in a rejection under 35 U.S.C. § 103 must qualify as "analogous art". According to the Federal Circuit in In re Clay, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992), in order for a reference to qualify as analogous art, it must be established that (1) the reference is from the same field of endeavor, regardless of the problem addressed by the invention, and (2) if the reference is not within the same field of endeavor, then the reference must be reasonably pertinent to the particular problem with which the invention is involved. As stated in In re Wood and Eversole, 202 USPQ 171,

174 (CCPA 1979), "[t]he rationale behind this rule precluding rejections based on combination of teachings of references from nonanalogous arts is the realization that an inventor could not possibly be aware of every teaching in every art."

According to M.P.E.P. § 2143, to establish a *prima facie* case of obviousness, (1) "there must be some suggestion or motivation, either in references themselves or in the knowledge generally available to one of ordinary skill in the art, to ... combine reference teachings"; (2) "there must be a reasonable expectation of success"; and (3) "the prior art ... references when combined ... must teach or suggest all the claim limitations". The Patent Office has the initial burden of establishing each of these requirements of a *prima facie* case of obviousness. In re Piasecki, 223 USPQ 785, 787 (Fed. Cir. 1984) and In re Warner, 154 USPQ 173 (CCPA 1967).

The combined teachings of references must provide some teaching, suggestion or incentive to support the asserted combination in order to establish a *prima facie* case of obviousness. In re Geiger, 2 USPQ2d 1276 (Fed. Cir. 1987). The motivation to modify a teaching must come from the prior art and not from Applicants' disclosure, as it is improper merely to use inventors' teachings against them in determining whether prior art references would have suggested the claimed invention to a person having ordinary skill in the art. W.L. Gore v. Garlock, Inc., 220 USPQ 303, 312-13 (Fed. Cir. 1983). Furthermore, "[t]he mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification". In re Gordon, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

The proposed modification also must have had a reasonable expectation of success to one having ordinary skill in the art at the time the invention was made. Amgen, Inc. v. Chugai Pharm. Co., 18 USPQ2d 1016, 1023 (Fed. Cir. 1991). The reasonable expectation of success must also have come from the prior art and not Applicants' disclosure. In re Vaeck, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991). Whether it would have been "obvious to try" or obvious to experiment by one having ordinary skill in the art is an improper basis for determining obviousness. In re Dow Chemical Co. v. American Cyanamid Co., 5 USPQ2d 1529, 1532 (Fed. Cir. 1988).

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising (a) supporting a semiconductor substrate in a plasma etch reactor, the substrate including a dielectric layer over a stop layer; (b) supplying an etchant gas to the plasma etch chamber; and (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas. As set forth below, the combination of references fails to teach or reasonably suggest all of the claim limitations. Further, persons of ordinary skill in the art would not have had the requisite reasonable expectation of success when combining the references in the manner suggested in the Official Action.

Hung Teaches Away From Using Oxygen

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free*

fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

Hung discloses an oxide etching process for selectively etching oxide over a feature having a non-oxide composition in a high-density plasma reactor using unsaturated fluorocarbons with a low but *finite hydrogen content* (See abstract, Column 5, lines 47-56 and Column 11, lines 1-10). Specifically, Hung uses a two-step oxide etch in order to obtain the desired selectivity to an underlying nitride layer (See Column 8, lines 26-34).

As disclosed by Hung, without a polymerizing fluorocarbon (such as CH_2F_2) in the over etch recipe, significant nitride corner faceting is observed (See column 10, lines 29-34). Thus, the over etch recipe of Hung is intended to "circumvent the *poor nitride selectivity of the main etch recipe*" (emphasis added, See column 10, lines 32-34).

In contrast to the claimed method, Hung does not disclose or suggest a method of etching a dielectric layer with selectivity to an underlying stop layer wherein the etchant gas comprises an *oxygen-containing* gas. Hung uses "a more heavily polymerizing fluorocarbon gas" in the over etch gas in order to obtain nitride selectivity (See column 8, lines 13-16). Hung's over etch to obtain "a complete etch without producing excessive nitride faceting" uses an etchant gas which is an oxygen-free gas. While Hung discloses use of *oxygen gas to remove the nitride layer* (column 10, lines 47-50), Hung specifically states that the *"oxygen destroys any nitride selectivity"* (Emphasis added, See column 10, line 51). Thus, Hung *teaches away* from using an oxygen-containing gas to etch a dielectric layer with selectivity to an underlying nitride layer.

Wang's Oxygen Gas is Incompatible with Hung's Oxygen-Free Gas

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

The Official Action cited Wang for disclosing the use of oxygen gas with the main-etchant gas. In particular, the Official Action cites a portion of Wang stating that "[t]he above processes can be modified by the addition of carbon monoxide, nitrogen, or oxygen, all of which are known to enhance selectivity and increase the etch stop margin" (column 10, lines 23-26). As pointed out above, Hung teaches away from using oxygen as part of the over etch gas. The Official Action fails to explain why one of ordinary skill in the art would have been led to go directly against the teachings of Hung, *i.e.*, Hung's teaching that "oxygen destroys any nitride selectivity" (column 10, line 51 of Hung).

Lack of Motivation and No Reasonable Expectation of Success

As discussed above, the Official Action has not set forth a tenable basis establishing the requisite motivation to combine Wang with Hung in a manner that would produce the claimed method. Furthermore, the Official Action does not set forth an explanation as to why one of ordinary skill in the art would have had a reasonable expectation of success in combining Hung and Wang as suggested in the Official Action. Given Hung's teaching to use a hydrogen-containing oxygen-free gas for the over etch and an oxygen-containing gas for removing the nitride layer, it is submitted that the Official Action fails to establish a reasonable expectation of success in modifying Hung to include the oxygen-containing gas

of Wang. Thus, it is submitted that a person of ordinary skill in the art would not have been led to use a hydrogen-free, oxygen-containing over etch gas to etch openings in the dielectric layer of Hung.

In view of the foregoing, Applicants respectfully submit that Claim 1 and all the claims dependent therefrom are clearly patentable over the combination of Hung and Wang.

Third Rejection

Claims 6-8 and 13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hung and Wang in further view of U.S. Patent No. 6,228,438 to Schmitt ("Schmitt"). The reasons for the rejection are set forth in numbered paragraph 4, on pages 7-8 of the Official Action. The Official Action alleges that Schmitt discloses a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (See column 8, lines 1-10) and it is argued that it would have been obvious to modify the etch process of Hung and Wang to include other commercially available plasma etch reactors. As to Claims 7 and 8, the Official Action acknowledges that "[t]he combined prior art does not disclose the flow rate of oxygen (O_2) for the process" but alleges oxygen is a result effective process variable. This rejection is respectfully traversed.

Claim 6 depends from Claim 1 and further sets forth that the plasma etch reactor comprises a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode, RF energy being supplied at two different frequencies to either the bottom electrode or at different first and second frequencies to the showerhead electrode and bottom electrode.

Claim 7 depends from Claim 1 and further sets forth that the etchant gas is nitrogen-free, the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 2 to 50 sccm C_4F_6, 2 to 50 sccm O_2 and 50 to 800 sccm Ar.

Claim 8 depends from Claim 1 and further sets forth that the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 10 to 25 sccm C_4F_6, 5 to 20 sccm O_2 and 50 to 300 sccm Ar.

Claim 13 depends from Claim 1 and further sets forth that the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the showerhead electrode being supplied 0 to 3000 watts of RF energy and the bottom electrode being supplied 0 to 3000 watts of RF energy.

The Etch Reactor of Schmitt is Unsuitable for Hung's Process

Regarding Claims 6 and 13, Hung relates to a process wherein a high-density plasma etch reactor is used (column 7, lines 33-48 and column 11, lines 1-10). Schmitt relates to a capacitively coupled RF plasma reactor which does not provide a high density plasma. Accordingly, because the plasma reactor of Schmitt would be unsuitable for Hung's high-density plasma etch process, it would not have been obvious to a person of ordinary skill in the art to modify Hung as suggested in the Official Action. As to Claims 6 and 8, the Official Action does not address Hung's teaching away from use of oxygen. As such, the Official Action does not establish that oxygen is a result effective variable in

Hung's process. Moreover, Claims 6-8 and 13 depend from Claim 1 and thus are patentable over the cited references for at least the reasons set forth above.

Fourth Rejection

Claims 1-5, 9-12 and 14-25 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,366,590 ("Kadomura") in view of Wang. The reasons for the rejection are set forth in numbered paragraph 5, on pages 8-12 of the Official Action. In particular, the Official Action alleges that (1) Wang discloses the use of an oxygen-containing gas with a fluorocarbon main etchant gas to etch an oxide (dielectric) layer; and (2) it is argued that it would have been obvious to modify the C_xF_y-based oxide etch of Kadomura to include the oxygen-containing gases of Wang. This rejection is respectfully traversed for the following reasons.

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising (a) supporting a semiconductor substrate in a plasma etch reactor, the substrate including a dielectric layer over a stop layer; (b) supplying an etchant gas to the plasma etch chamber; and (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas. As set forth below, the combination of references fails to teach or reasonably suggest all of the claim limitations. Further, persons of ordinary skill in the art would not have had the requisite reasonable expectation of success when combining the references in the manner suggested in the Official Action.

Kadomura Teaches Away From Using Oxygen

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

Kadomura discloses an oxide etching process for selectively etching oxide with respect to nitride (See abstract and Column 3, lines 30-44). Specifically, Kadomura uses a high density plasma with an etching gas composed of a fluorocarbon compound represented by the formula C_xF_y (where $y \leq x+2$) (See Column 3, lines 30-44).

In contrast to the claimed method, however, Kadomura does not disclose or suggest a method of etching a dielectric layer with selectivity to an underlying stop layer wherein the etchant gas comprises an *oxygen-containing* gas. Instead, Kadomura discloses that a gas mixture composed of a fluorocarbon gas (such as CH_2F_2) and CO_2 (an oxygen-containing gas) can be used to etch a Si_xN_y layer with selectivity to an SiO_x layer (See column 2, lines 16-30). In other words, Kadomura adds oxygen to obtain faster etching of silicon nitride compared to silicon oxide. Thus, Kadomura *teaches away* from using an oxygen-containing gas to etch a dielectric layer with selectivity to an underlying nitride layer.

Wang's Oxygen Gas is Incompatible with Kadomura's Oxygen-Free Gas

The Official Action cited Wang for disclosing the use of oxygen gas with the main-etchant gas. In particular, the Official Action cites a portion of Wang stating that "[t]he above processes can be modified by the addition of carbon monoxide, nitrogen, or oxygen,

all of which are known to enhance selectivity and increase the etch stop margin" (column 10, lines 23-26). As pointed out above, Kadomura adds oxygen to increase the etch rate of silicon nitride compared to silicon oxide. In contrast, Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas. The Official Action fails to explain why one of ordinary skill in the art would have been led to go directly against the teachings of Kadomura.

Lack of Motivation and No Reasonable Expectation of Success

As discussed above, the Official Action has not set forth a tenable basis establishing the requisite motivation to combine Wang with Kadomura in a manner that would produce the claimed method. Furthermore, the Official Action does not set forth an explanation as to why one of ordinary skill in the art would have had a reasonable expectation of success in combining Kadomura and Wang as suggested in the Official Action. Given Kadomura's teaching to use an oxygen-containing gas for removing the nitride layer, it is submitted that the Official Action fails to establish a reasonable expectation of success in modifying Kadomura's oxide etch to include the oxygen-containing gas of Wang. Thus, it is submitted that a person of ordinary skill in the art would not have been led to use a

hydrogen-free, oxygen-containing over etch gas to selectively etch openings in the dielectric layer of Kadomura.

In view of the foregoing, Applicants respectfully submit that Claim 1 and all the claims dependent therefrom are clearly patentable over the combination of Kadomura and Wang.

Fifth Rejection

Claims 6-8 and 13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Kadomura and Wang in further view of Schmitt. The reasons for the rejection are set forth in numbered paragraph 6, on pages 12-13 of the Official Action. The Official Action alleges that Schmitt discloses a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (See column 8, lines 1-10) and argues that it would have been obvious to modify the etch process of Kadomura and Wang to include other commercially available plasma etch reactors.

Claims 6-8 and 13 depend from Claim 1 and thus are patentable over the cited references for at least the reasons that Claim 1 is patentable over Hung and Wang.

It is submitted that the differences between the claimed subject matter and the prior art are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

In view of the foregoing, it is submitted that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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